


Recent Results on SNRs and PWNe from the Fermi Large Area Telescope

*Elizabeth Hays
(NASA/GSFC)
On behalf of the Fermi LAT
Collaboration*



Fermi LAT Collaboration


- France
 - IN2P3, CEA/Saclay
- Italy
 - INFN, ASI, INFAP
- Japan
 - Hiroshima University
 - IRAS/NASA
 - RIKEN
 - Tokyo Institute of Technology
- Sweden
 - Royal Institute of Technology (KTH)
 - Stockholm University
- United States
 - Stanford University, SLAC and HEPL (Physicist)
 - University of California at Santa Cruz - Santa Cruz Institute for Particle Physics
 - Coddard Space Flight Center
 - Naval Research Laboratory
 - Sonoma State University
 - Ohio State University
 - University of Washington

Principal Investigator:
Peter Michelson (Stanford University)

~190 Scientific Members including 36
Affiliated Scientists, plus 40 Postdocs
and 100 Students

Manager of LAT

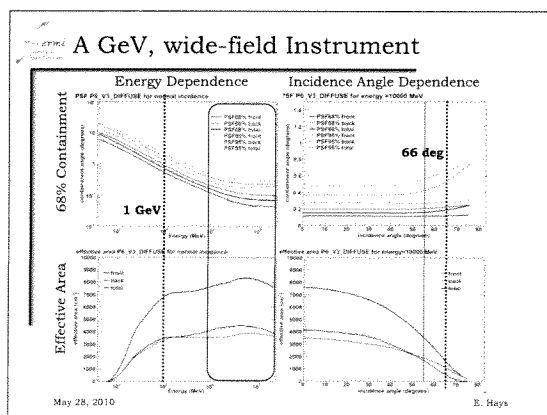
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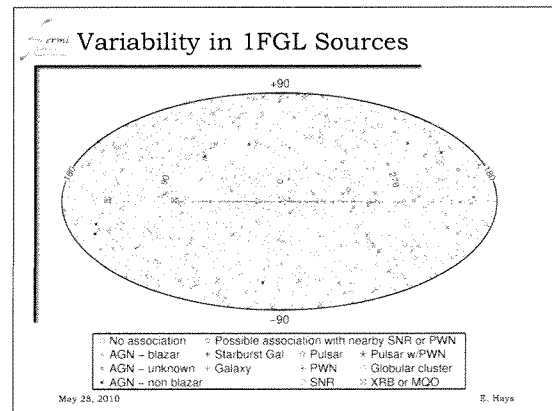
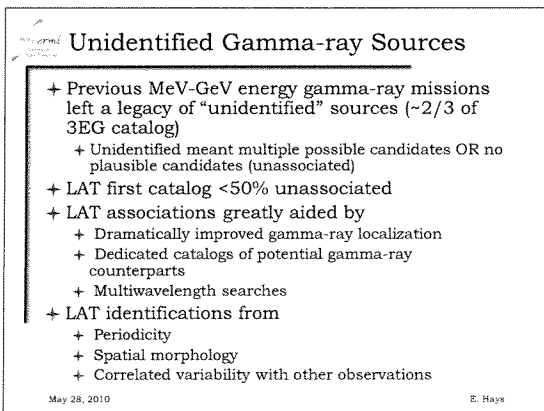
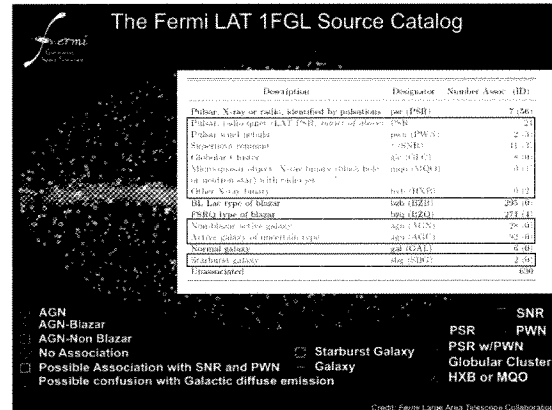
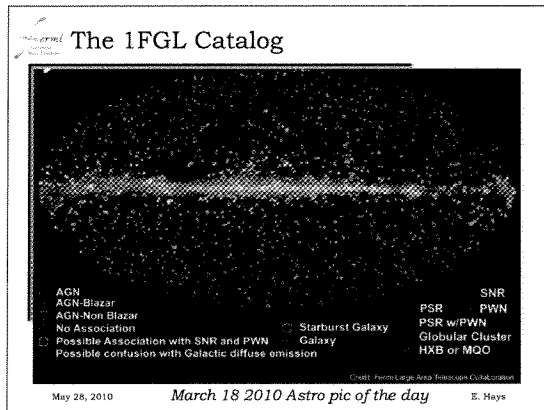


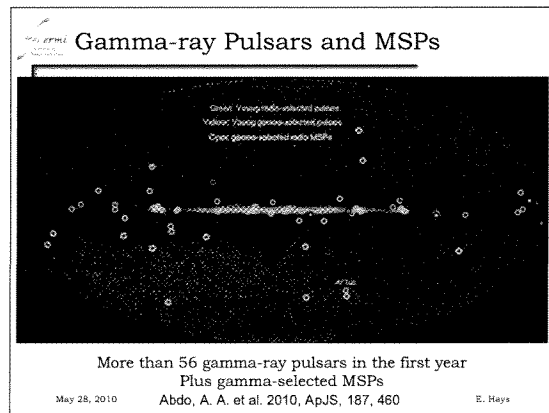
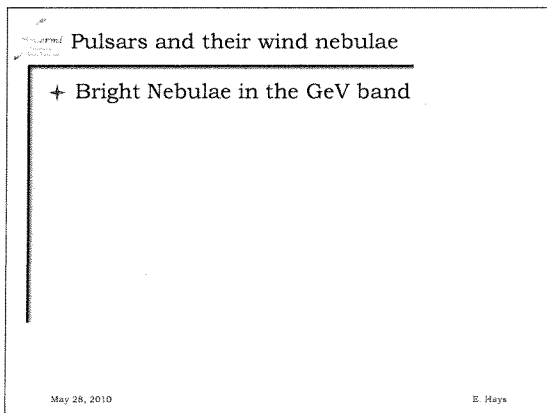
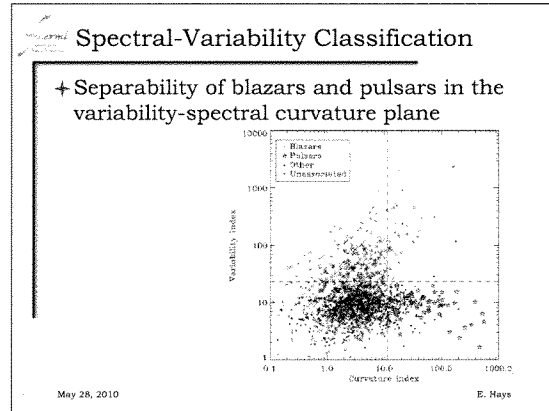
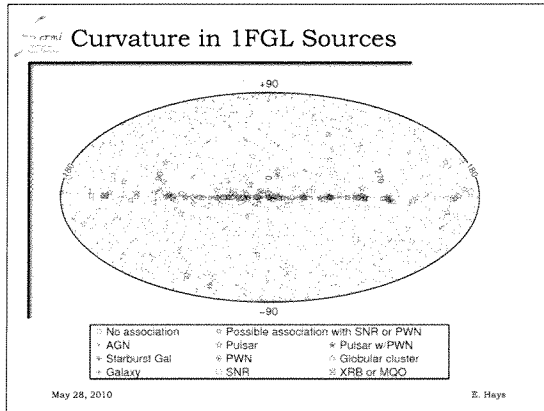
Galactic Results from LAT

- + 1FGL Galactic populations
 - + The seen, the unseen, and the unknown
- + Selected Highlights
 - + Pulsars
 - + Pulsar Wind Nebulae
 - + Supernova Remnants
 - + Transients
- + Future Prospects

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GeV PWN Search

- + Known high-energy PWNe
 - + From X-ray and TeV observations
 - + Crab, Vela X, MSH 15-52 nebulae...
- + Off-peak searches of gamma-ray pulsars
 - + Catalog from LAT team underway
- + Young, energetic radio pulsars
- + TeV nebula candidates

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Crab Pulsar and Nebula

Pulsar 100 MeV to 20 GeV

PRELIMINARY

Hyper-exponential cutoff excluded at ~ 5 sigma. Consistent with emission well above the neutron star surface

Nebula from MeV to TeV

PRELIMINARY

Inverse Compton emission consistent with mean magnetic field in nebula $100 \mu\text{G} < B < 200 \mu\text{G}$

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Abdo, A. A. et al. 2010, ApJ, 708, 1254

Vela X: Nebula of the Vela Pulsar

Excess counts $E > 800$ MeV

Profile

Data compared with a simulated point source at position of Vela Pulsar

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Abdo, A. A. et al. 2010, ApJ, 713, 146

MSH 15-52

$E > 1$ GeV

$E > 10$ GeV

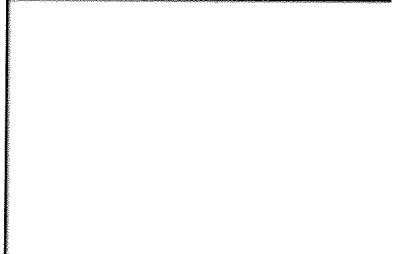
E' (GeV) [log cm⁻² s⁻¹]

Energy [eV]

Legend: \bullet decay, \circ synchrotron, \square on CRB, \triangle on 10, \diamond on straight, \times on 100

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Supernova Remnants

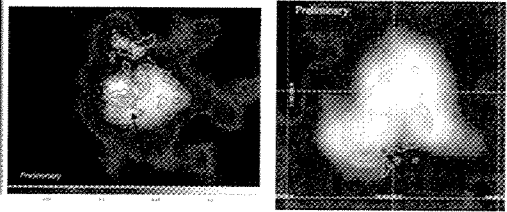


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Resolved GeV Sources

Bright gamma-ray sources associated with several supernovae interacting with molecular clouds
Extension resolved in LAT data



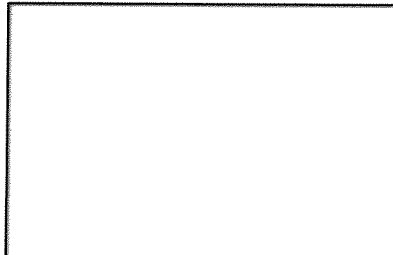
LAT counts map (2-8 GeV)
X-ray (0.1-2.4 keV, black) and
radio (1.4 GHz, green) contours

LAT counts map (2-10 GeV)
Radio (1.4 GHz, green) contours

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Galactic Transients



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LAT Unassociated Transient Detections



- ☆ Unassociated transients from daily search
- Low latitude blazars from First LAT Catalog

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Gamma rays from a Nova

- + Fermi J2102+4542
- + Located in the direction of the Cygnus region
- + Bright, high confidence, detected over several days by automated processing
- + No likely blazars in error circle...

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V 407 Cygni - a symbiotic nova

+ Position and timing consistent with V 407 Cygni, a recurrent nova detected in outburst ~2 days before the Fermi report

AAVSO Data & HST WISE/ Cyg - WWW.AAVSO.ORG

Mag. (kilo)

Julian Date

Visual (filled circle) UVexcess (open circle)
Unknown (filled square) I (open square)

2455600 2455800 2456000 2456200


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V407 Cygni: a variable star

Symbiotic binary:
White dwarf star and red giant star
orbiting each other

Near Deneb in Cygnus



- Mira variable star
- White dwarf accretion
- Binary interaction

A complex and fascinating system!

V407 Cyg ~ 6000 light years
away

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March 11 - A Nova!

Hydrogen accreting on to the surface of the white dwarf ignites a nuclear explosion (30-60 of these per year in Milky Way)

Candidate nova discovered by amateur astronomers, Nishiyama and Kobashima

Fermi detects a new gamma-ray source in the same field on March 13 (ATEL #2487)

Usually below here

Optical lightcurve

AAVSO DATA FOR VEE / Cyp: WWW.AAVSO.ORG

Mag./rds

2455268.80 2455272.47 2455276.18 2455280.00

Mar 11 2455280.80 2455284.47 2455288.18 2455292.00

Julian Date

Mar 11 12 PM

14 PM

16 PM

18 PM

20 PM

22 PM

24 PM

26 PM

28 PM

30 PM

32 PM

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728 PM

730 PM

732 PM

734 PM

736 PM

738 PM

740 PM

742 PM

744 PM

746 PM

748 PM

750 PM

752 PM

754 PM

756 PM

758 PM

760 PM

762 PM

764 PM

766 PM

768 PM

770 PM

772 PM

774 PM

776 PM

778 PM

780 PM

782 PM

784 PM

Symbiotic Nova

- + Symbiotic Binary System: White dwarf + red giant system
- + Nova: White dwarf builds up mass envelope to the point of thermonuclear fusion
 - + Dramatic increase in visual magnitude
- + Recurrent Nova?
 - + Hints but no strong confirmation of previous nova
- + Pre-nova activity
 - + White dwarf shows ongoing variability at level of several in magnitude
 - + V407 Cyg companion is a Mira star showing variability at level of several in magnitude
 - + Dusty environment with stellar wind
- + Origin of the gamma rays?
 - + Strong shock propagating into dense medium around giant star (and stellar wind)
 - + Pion decay or electron processes? (bremsstrahlung)

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Summary

<http://fermi.gsfc.nasa.gov>

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Extras

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Pulsars everywhere...

- + >50 gamma-ray pulsars so far
- + >40 young, energetic pulsars
- + 9 old, recycled millisecond pulsars
- + Identifying EGRET unidentifieds and LAT unidentifieds
- + Gamma-ray beam is bigger than radio beam
- + Pulsar spectra have exponential cutoffs in the GeV band
- + Gamma rays from outer magnetosphere preferred
- + Bonus: LAT unidentifieds also turning up new radio millisecond pulsars

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